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Development of Physics Learning Instrument with Model Project Based Learning to Train Students' Critical Thinking Skills

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Abstract

This research is aimed to produce physics learning instrument with appropriate project based learning models and be able to train critical thinking skills in senior high school students. The research was conducted in the second semester of 2018/2019 academic year in the Senior High School of Amanatul Ummah Surabaya. Learning instrument developed refers to the design of 4-D development. The data were collected by observation, tests, interviews, questionnaires and documentation. Data analysis techniques used include analysis of validity. The results showed that the learning instrument developed (syllabus, lesson plans, teaching materials, student worksheet, and critical thinking skills test instruments) were valid categories, it can be concluded that the learning instrument developed has satisfy the criteria of validity so that it is worth using to train critical thinking skills in students.

Keywords: Physics Learning Instrument; Project Based Learning; Critical Thinking

Introduction

21st century education is required to emphasize critical thinking and problem solving, creativity and innovation, communication, collaboration, and global awareness (Marjohan, 2013). From these characteristics critical thinking is one of the things that must be prioritized in today's education. One lesson that requires critical thinking skills is physics. Physics is one of the branches of science that underlies the development of advanced technology and the concept of living in harmony with nature (Ministry of National Education, 2006a). Mastery of the concept of physics must be emphasized on technological progress and its impact on the environment. It is an embodiment of education which is reciprocal adaptation to the natural environment and fellow human beings.

The application of critical thinking skills in Indonesia has actually begun in recent years. One of these applications is in the implementation of the High School National Examination (UNBK). In UNBK there are physics questions with a high level of difficulty and require critical thinking skills to solve them. However, this application has yet to show maximum results. According to Lestari (2011), at present the

problems that occur in physics learning, namely learning that is applied by the teacher only gives little opportunity for students to be actively involved in the learning process. This causes learning to occur in only one direction. In addition, according to Yusuf (2009) the current picture of learning is more about memorizing concepts or formulas, whereas in physics the problems that occur a lot are complex problems. This is directly proportional to the fact that researchers found in the Amanatul Ummah Surabaya High School, from the results of observations in the school not a few students experienced difficulties, especially in applying physics concepts in various problems. This is because in teaching at school, students are not directly involved in finding these concepts, so that when students are faced with problems that require analysis, students have difficulty finding solutions to a number of complex problems. In connection with these matters to maximize the results of physics learning, the physics learning process must be made meaningful learning.

Project based learning learning model is one of learning that makes students as the subject and focus of learning. According to Nur (2008c) project based learning aims to develop basic knowledge in relation to the real world context, develop scientific reasoning skills and develop conscious attitudes to the value of teamwork. In addition to being oriented to students, project learning is also emphasized in students' ability to solve problems. Because physics is a natural science, the problems that occur a lot are complex problems. Of the complex problems in physics, of course also have solutions with high-level thinking. One of the high-level thoughts used in learning is critical thinking skills.

Physics learning in schools should be able to develop competencies in critical thinking among students. By becoming a critical individual, students will be triggered to be creative and will try to find solutions using various alternative strategies. According to Glaser (Fisher, 2008) critical thinking is interpreted as; 1) an attitude of thinking deeply about problems and things that are within the range of one's observation, 2) knowledge of methods of examination and logical reasoning, and 3) skills to examine supporting evidence and further conclusions.

Based on the explanation above, this study aims to develop an innovation in the learning process. This research develops a learning device through a project based learning model. The results of this development research are expected to produce learning instrument that are able to train students' critical thinking skills.

Literature Review

Learning instrument are a tool used by teachers and students in carrying out learning activities in the classroom. In its implementation, learning learning instrument includes; syllabus, learning implementation plan (RPP), textbooks, Student Worksheet (LKPD), and question instruments. According to Nieveen (1999) A learning device is said to have good quality if it meets several indicators which include validity, practicality, and effectiveness. According to Akker (1999), the validity of learning instrument refers to the latest knowledge (content validity) and the intervention components are interrelated with each other (construct validity). The understanding of the learning instrument developed can be described in the following table.

Table 1. Definition of learning instrument developed

No.	Instrument	Definition
1.	Syllabus	Syllabus is a learning design that contains a plan for teaching materials for certain subjects at a particular level or class, as a result of selection, grouping, sequencing, and presentation of curriculum material (Majid, 2008).
2.	RPP	The learning implementation plan (RPP) is a form of procedure and management of learning to achieve basic competencies that have been set in content standards (curriculum standards). RPP is the elaboration of syllabus in the form of learning scenarios (Permendikbud No. 22 of 2016).
3.	Textbooks	Textbooks are textbooks that are used as standard references on certain subjects (Akbar, 2013).
4.	LKPD	LKPD is a printed teaching material in the form of sheets of paper containing summary material, and instructions for the implementation of learning tasks that must be done by students, which refers to basic competencies that must be achieved (Prastowo, 2011).
5.	Test instrument	According to Puerwanti, et. Al. (2008) developing tests as instruments for assessing processes and learning outcomes is to compile a measure of a symptom that is abstract, namely the understanding and mastery of students towards the material.

According to Ratumanan (2015) project based learning (PjBL) is learning that uses projects as the center/core. Projects are complex tasks that are based on challenging questions or problems, which involve students to design, solve problems, make decisions, or conduct investigative activities, and provide opportunities for students to carry out autonomous activities in a long time and peak in the form of realistic products and presentation.

The syntax of project based learning as developed by The George Lucas Education Foundation (2005) consists of; 1) Start with essential question, 2) Design a plan for the project, 3) Create a schedule, 4) Monitor the students and the progress of the project, 5) Assess the outcome, 6) Evaluate the experience.

Hans Bhattacharya identifies there are five advantages of implementing a project based learning learning model, namely; 1) Increasing learning motivation, 2) Increasing skills of students in problem solving, 3) Improving skills using learning media, 4) Increasing enthusiasm and collaborative skills, 5) Increasing skills in management of various resources.

The following table describes the indicators of critical thinking skills with the implementation of learning using a project based learning learning model.

Table 2. The relationship between the project based learning model and critical thinking skills

Phase PjBL	Indicator of Critical Thinking Skills	Learning Activities
Start with essential question	Interpretation	Learning starts with basic questions. The question was made as an assignment in carrying out the project.
Design a plan for the project	Analysis	Project determination is done collaboratively. Students are given the freedom to complete their tasks in their own way.
Create a schedule	-	Teachers and students collaboratively arrange an activity schedule in completing projects during learning.
Monitor the students and the progress of the project	Evaluation dan Inference	The teacher is responsible for monitoring students when completing the project. The teacher acts as a mentor and facilitates students in each process.
Assess the outcome	Eksplanation	Assessment is done to help teachers measure achievement and evaluate the progress of students.
Evaluate the experience	Evaluation	Teachers and students reflect on project activities and results. Students express their feelings and experiences during completing the project.

Method

This research was conducted in the Superior High School Amanatul Ummah Surabaya. The population used was all students of class X IPA 3 by taking a sample of 23 students. This research is a development research that refers to the 4-D model. This model consists of 4 development stages, namely: define, design, develop, and disseminate. Data collection methods used include observation, interviews, and questionnaires. The data analysis technique used is validity analysis.

Result and Discussion

Products developed, validated by experts or practitioners. In the validation of this device using two validators from Suranbaya state university lecturers. Validation carried out by the validator includes

syllabus, lesson plans, textbooks, LKPD, and test instruments. The validation instrument used is a questionnaire containing scores (ranging from 1 to 4) for each learning device. Data from the validation results were analyzed using qualitative descriptive analysis techniques. Percentage of appraisal match of two validators of physics products based on the inter observer agreement obtained from statistical analysis of percentage of agreement (R) (Borich, 1994):

$$R = \left[1 - \frac{A - B}{A + B} \right] \times 100\%$$

Information:

R = percentage of agreement,

A = the highest score of 2 assessors,

B = lowest score of 2 assessors

The results of the validation test obtained are as follows: first, the syllabus validation test. In general, the syllabus developed has very valid criteria with a final average score of 3.8. The percentage of suitability of the syllabus developed was 93%. Second, RPP validation test. In general, the developed RPP has very valid criteria with a final average score of 3.7. The percentage of appraisal of the RPP developed was 98%. Third, the validation test of textbooks. In general, developed textbooks have a valid category with a final average score of 3.4. The percentage of suitability of the assessment of the developed textbook is 96%. Fourth, validation test of LKPD. In general, the developed LKPD has a valid category with a final average score of 3.6. The percentage of suitability of the assessment of the LKPD developed was 93.3%. Fifth, test the validation of the Critical Thinking Skills Test Instrument. In general the Ability Test developed has a valid category with a final average score of 3.6. The percentage of appraisal of the ability test developed is 95%.

Conclusion

Based on research data and research data analysis, it can be concluded that physics learning devices with project based learning models that are developed are suitable for use in learning and can train students' critical thinking skills in high school.

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